tom **101** may be prepared as a first phantom equipped with a set of pillars **113** planted along the reference-plane trajectory OR_s only and a second phantom equipped with a set of pillars **113'** planted along the outer-plane trajectory OR_{outer} (or an inner-plane trajectory, although not shown). In this example, two-time scans are performed for the first and second phantoms and two panoramic images are reconstructed from results obtained by the respective scans, so that the foregoing measurement can be performed.

Furthermore, these first and second phantoms may be produced separately from each other but can be assembled into the one universal type phantom **101**. In this configuration, the first and second phantoms themselves are stored separately from each other until measurement, but can be used as one phantom the measurement is performed.

The present invention will not be limited to the foregoing embodiment, and, needless to say, the embodiment can be modified into various types as long as modifications depart from the gist of the present invention. For example, the rotation unit **24** may be structurally modified such that, when the X-ray tube **31** and the detector **32** are driven to rotate (move) around the oral cavity of the patient P, the X-ray tube **31** and the detector **32** are obliquely to each other during which the X-ray beam is scanned. Alternatively, a scan based on this "mutually-oblique opposition" and a further scan based on the "mutually-direct opposition" described in the foregoing embodiment may be combined appropriately with each other. This combination can be selectively applied depending on which portion of the tooth row in a patient's oral cavity is scanned. This makes it possible to enable the X-ray beam to, as much as possible, perpendicularly pass through each portion of the tooth row at any time, whereby the X-ray beam can be radiated at angles where overlaps of teeth and/or undesired imaging of the cervical spine are prevented as much as possible. Accordingly, it is possible to reconstruct panoramic images with fewer artifacts.

By the way, the radiation imaging apparatus according to the present invention is not restricted to dental panoramic imaging apparatuses, but can be produced as apparatuses which three-dimensionally examine actual shapes (positions) of an object using the tomosynthesis method. Such applications include, as medical modalities, a mammography apparatus and a scanner for examining lung cancer, which are based on this tomosynthesis method.

INDUSTRIAL APPLICABILITY

According to the present invention, for imaging, measurement of the phantom makes it possible to easily and accurately analyze and calibrate parameters structurally defining the imaging space, which parameters concern with positions, distances, and angles of the X-ray tube, the 3D referential tomographic plane, and the detector. It is therefore possible to provide a radiation-based imaging apparatus which is capable of three-dimensionally imaging objects at higher accuracy.

DESCRIPTION OF REFERENCE NUMBERS

1 Dental panoramic imaging apparatus (radiation imaging apparatus)
12 Computer
14 Imaging unit
31 X-ray tube (radiation source)
32 Detector
33 Collimator
41 High-voltage generator
53 Buffer memory
54 Image memory
55 Frame memory
56 Image processor
57 Controller
58 Operation device
60 Monitor
101 Phantom
111 Base
113, **113'** Support pillar member
114 to **116** Phantom

What is claimed is:

1. A radiation imaging apparatus comprising:

a radiation source that radiates X-rays;

a detector that is arranged to be opposed to the radiation source and that outputs, frame by frame, a frame of digital electric two-dimensional data corresponding to the X-rays entering the detector;

rotating means for relatively rotating the radiation source and the detector to the object, such that an object being imaged is located between the radiation source and the detector and a predetermined fixed point on a virtual line connecting the radiation source and the detector at each rotation angle is positionally changed to the object during the rotation in an imaging space provided between the radiation source and the detector;

data acquiring means for acquiring, frame by frame, the data outputted from the detector while the radiation source and the detector, the detector, or the object is moved by the rotating means,

the data acquired being produced into a three-dimensional image of an imaging portion of the object;

a phantom arranged in the imaging space to be located at predetermined tomographic planes in the imaging space and configured to have markers with which known positional information in the imaging space is imaged with the X-rays;

image producing means for producing, based on a tomosynthesis technique, an image from the data acquired by the data acquiring means in response to the X-rays emitted from the radiation source in a state where the phantom is arranged in the imaging space;

first calculating means for calculating, based on the known positional information of the markers and information indicative of positions of the markers obtained from the image, information indicative of a distance between the radiation source and the detector and information indicative of a height of the radiation source relative to the detector; and

second calculating means for calculating, based on results calculated by the first calculation means and the data, a parameter defining a positional relationship among the radiation source, the detector, and the tomographic planes in the imaging space by taking into account positional changes of the fixed point on the virtual line to the object when the radiation source and the detector are relatively rotated around the object.

2. The radiation imaging apparatus of claim **1**, wherein

the radiation source is an X-ray tube that radiates an X-ray as the X-rays,

the detector is a detector that detects the X-rays,

the rotating means rotates the pair of the radiation source and the detector around the object along orbits having mutually different curvature factors and at angular velocities, the orbits including circular orbits or ellipsoidal orbits, and rotates the pair such that the X-ray tube and the detector are always directly opposed to each other, and